Assessment of the Safety Risk of Dermatoscope Magnets in Patients With Cardiovascular Implanted Electronic Devices

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Abstract: Importance Cardiovascular implanted electronic devices (CIEDs) are susceptible to electromagnetic interference. Dermatologists regularly use devices containing magnets, including dermatoscopes and their attachments, which could pose a hazard to patients with CIEDs. Objective To investigate the safety risk of magnets in dermatoscopes to patients with CIEDs. Design, Setting, and Participants This cross-sectional observational study was conducted between January 1, 2018, and March 31, 2018, in a controlled laboratory setting. Two experiments were performed. In the first experiment (performed in the Dermatology Service at Memorial Sloan Kettering Cancer Center, New York), dermatoscopes that contain magnets were obtained from 3 manufacturers. Using a magnometer, the magnetic field strength of the dermatoscopes was measured over the magnet; at the faceplate; and at a distance of 0.5 cm, 1 cm and 15 cm away from the faceplate. In the second experiment (performed in the University Heart Center Zurich, Zurich, Switzerland), ex vivo measurements were conducted to determine how the dermatoscopes affected old-generation and new generation CIEDs (pacemakers and implantable defibrillators). Main Outcomes and Measures Magnetic field strength as measured directly over the dermatoscope magnet; at the faceplate; and at distances of 0.5 cm, 1 cm, and 15 cm from the faceplate. Pacemaker and defibrillator operation when exposed to dermatoscopes. Results After conducting 24 measurements, the magnetic field (measured in gauss [G]) strength varied between 24.26 G and 163.04 G over the dermatoscope magnet, between 2.22 G and 9.98 G at the dermatoscope faceplate, between 0.82 G and 2.4 G at a distance of 0.5 cm, and between 0.5 G and 1.04 G at a distance of 1 cm; it was 0 for all devices at a 15 cm distance. The field strength at the faceplate was found to be generally below the CIED industry standard safety threshold. None of the dermatoscopes in the ex vivo experiment exerted any demonstrable disruptions or changes to the CIEDs. Conclusions and Relevance In real life, dermatoscope magnets likely present no measurable safety risk to patients with CIEDs. Using the polarized noncontact mode permits dermoscopy to be performed at least 0.5 cm from the skin surface, where the magnetic field strength was well below the 5-G safety threshold.

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Assessment of the Safety Risk of Dermatoscope Magnets in Patients With Cardiovascular Implanted Electronic Devices

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IMPORTANCE Cardiovascular implanted electronic devices (CIEDs) are susceptible to electromagnetic interference. Dermatologists regularly use devices containing magnets, including dermatoscopes and their attachments, which could pose a hazard to patients with CIEDs.

OBJECTIVE To investigate the safety risk of magnets in dermatoscopes to patients with CIEDs.

DESIGN, SETTING, AND PARTICIPANTS This cross-sectional observational study was conducted between January 1, 2018, and March 31, 2018, in a controlled laboratory setting. Two experiments were performed. In the first experiment (performed in the Dermatology Service at Memorial Sloan Kettering Cancer Center, New York), dermatoscopes that contain magnets were obtained from 3 manufacturers. Using a magnometer, the magnetic field strength of the dermatoscopes was measured over the magnet; at the faceplate; and at a distance of 0.5 cm, 1 cm and 15 cm away from the faceplate. In the second experiment (performed in the University Heart Center Zurich, Zurich, Switzerland), ex vivo measurements were conducted to determine how the dermatoscopes affected old-generation and new generation CIEDs (pacemakers and implantable defibrillators).

MAIN OUTCOMES AND MEASURES Magnetic field strength as measured directly over the dermatoscope magnet; at the faceplate; and at distances of 0.5 cm, 1 cm, and 15 cm from the faceplate. Pacemaker and defibrillator operation when exposed to dermatoscopes.

RESULTS After conducting 24 measurements, the magnetic field (measured in gauss [G]) strength varied between 24.26 G and 163.04 G over the dermatoscope magnet, between 2.22 G and 9.98 G at the dermatoscope faceplate, between 0.82 G and 2.4 G at a distance of 0.5 cm, and between 0.5 G and 1.04 G at a distance of 1 cm; it was 0 for all devices at a 15 cm distance. The field strength at the faceplate was found to be generally below the CIED industry standard safety threshold. None of the dermatoscopes in the ex vivo experiment exerted any demonstrable disruptions or changes to the CIEDs.

CONCLUSIONS AND RELEVANCE In real life, dermatoscope magnets likely present no measurable safety risk to patients with CIEDs. Using the polarized noncontact mode permits dermoscopy to be performed at least 0.5 cm from the skin surface, where the magnetic field strength was well below the 5-G safety threshold.

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Cardiovascular implanted electronic devices (CIEDs) are susceptible to electromagnetic interference (EMI); that is, their operation is disrupted when they are exposed to an electromagnetic field. Electromagnetic interference could potentially result in asynchronous or nonphysiological pacing in pacemakers and could deactivate tachytherapies in defibrillators.[1] This outcome is usually temporary, although permanent shutdown of a defibrillator has been reported.[2] According to various CIED manufacturers, the strength of magnetic fields interacting with CIEDs (measured in gauss [G]) should not exceed the industry standard of 5 G to 10 G.[3-5]

Various devices that contain magnets are regularly used by clinicians, including dermatoscopes, cellular phones, and computer tablets. Some of these devices could theoretically affect the functionality of CIEDs. In a study, the Apple iPad 2 triggered the magnet mode in a CIED when laid on the skin over the device.[6] As a general precaution, some manufacturers advise keeping a distance of 15 cm between CIEDs and cellular phones or computer tablets.[4,7] Recently, the US Department of Veterans Affairs National Center for Patient Safety (NCPS) recounted this issue and requested data regarding magnet strength from major dermatoscope manufacturers. Accordingly, the NCPS calculated a distance of 0.3 cm to 2.9 cm from the dermatoscopes at which the 5-G threshold would theoretically be reached. Additionally they estimated the magnetic field strength to range from 0.0002 G to 0.18 G at a distance of 15 cm from the dermatoscopes. The NCPS issued a safety notification that recommended maintaining a distance of at least 15 cm between a CIED and a dermatoscope, computer tablet, or other magnet-containing devices. The 15 cm distance recommendation incorporates a large safety factor and provides guidance consistent with the recommendations for cellular phones and computer tablets. The National Center for Patient Safety itself did not perform any testing on dermatoscopes and CIEDs, and its recommendations are based solely on calculations using industry data. Both skin cancer rates and CIED prevalence are increasing, particularly in white males older than 65 years.[8,9] Hence, encountering suspected skin lesions in the vicinity of CIEDs is likely to be an ever more frequent scenario. The purpose of this study was to investigate the safety risk of magnets in dermatoscopes to patients with CIEDs.

Key Points

Question Can magnets in dermatoscopes pose a safety risk to patients with cardiovascular implanted electronic devices?

Findings In this cross-sectional study of 3 different dermatoscope models, the magnetic field measured directly above the magnets in each device was stronger than the manufacturer-recommended 5 gauss to 10 gauss threshold. However, the gauss readings at the faceplate of these devices were either substantially low or below the 5-gauss safety threshold.

Meaning In real life, dermatoscope magnets likely present no measurable adverse outcomes in patients with cardiovascular implanted electronic devices.

Methods

This study did not involve human subjects and, according to standard operating practice at Memorial Sloan Kettering Cancer Center, is therefore not in the purview of the institutional review board. We conducted the study between January 1, 2018, and March 31, 2018.

We approached 3 major dermatoscope manufacturers (3Gen, Canfield Scientific Inc, and Heine Optotechnik) for a list of all of their dermatoscope models that contain magnets. Accordingly, we obtained 1 of each dermatoscope device (DermLite DL4 and DL4w [3Gen], VEOS HD1 and HD2 [Canfield Scientific Inc], and NC1 and NC2 [Heine Optotechnik]) for testing purposes. The first experiment was performed in the Dermatology Service, Memorial Sloan Kettering Cancer Center, New York. Using a magnometer (PCE-MFM 3000; PCE Americas), we measured the G strength of these dermatoscopes at the faceplate and at a distance of 0.5 cm, 1 cm, and 15 cm from the faceplate. In addition, after removal of the faceplate, we measured the gauss strength directly over the magnet of each dermatoscope. We calculated the mean value of 5 repetitive measurements for each device and each magnet.

We performed a second set of experiments in a controlled laboratory setting (University Heart Center Zurich, Zurich, Switzerland) to determine how magnets in dermatoscopes affect ex vivo CIED functionality. These experiments entailed placing dermatoscopes (DL4 and VEOS HD1 and HD2) in contact with both old-generation (Cylos 990 DR pacemaker and Lumax 540 DR-T defibrillator; Biotronik) and new-generation (Biotronik Edora 8 DR-T pacemaker and Ilivia 7 HF-t defibrillator; Biotronik) CIEDs. We monitored the functionality of the device by visualization on a cardiac monitor. We placed each dermatoscope in contact with the CIED for 30 seconds and repeated this task 25 times for each CIED. We also placed a magnet (Biotronik), designed to intentionally induce the magnet mode in CIEDs, on the same CIED for 30 seconds.

Results

The magnetic field strength measurements over the magnet varied between 24.26 and 163.04 G. The measurements at the faceplate varied between 2.22 and 9.98 G. The magnetic field strength continued to decrease when the distance from the faceplate increased, varying between 0.82 G and 2.4 G at 0.5 cm, between 0.5 G and 1.04 G at 1 cm, and 0 for all devices at 15 cm (**Table**; **Figure**).

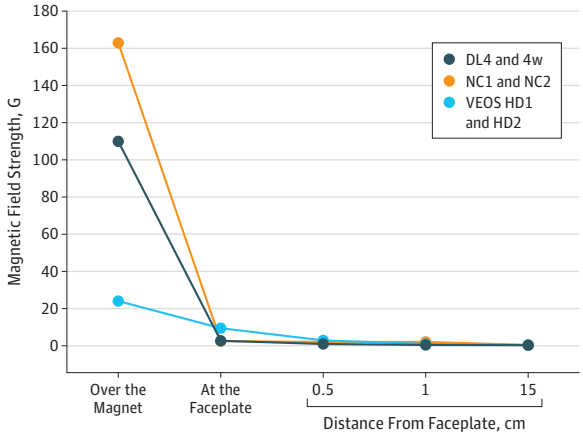
None of the tested dermatoscopes exerted any demonstrable force on the pacemakers and defibrillators after repetitive 30-second exposures. Exposure of these CIEDs to the Biotronik cardiologic magnet immediately shut down the defibrillators' tachycardia function and put the pacemakers in safe mode (ie, 70 beats per second).

Table. Mean Gauss Reading for Tested Dermatoscopes

Dermatoscope	Reading, Mean (SD), G				
	Over Magnet	At Faceplate	0.5 cm Distance From Faceplate	1 cm Distance From Faceplate	15 cm Distance From Faceplate
DL4 and 4w	110.38 (18.2)	2.58 (0.18)	0.82 (0.15)	0.5 (0)	0 (0)
NC1 and NC2	163.04 (25.2)	2.22 (0.24)	1.5 (0.19)	1.04 (0.08)	0 (0)
VEOS HD1 and HD2	24.26 (3.2)	9.98 (0.52)	2.4 (0.12)	1 (0)	0 (0)

Abbreviation: G, gauss.

Figure. Magnetic Field Strength as a Function of the Distance From the Dermatoscope Magnet



Magnetic field strength of dermatoscopes (DL4 and 4W, NC1 and NC2, and VEOS HD1 and HD2) as measured over the magnet; at the faceplate; and at a 0.5 cm, 1 cm, and 15 cm distance from the faceplate.

Discussion

To appreciate the likely risk of magnets to patients with CIEDs, one must understand how magnetic fields are measured. Magnetic field strength is calculated by the following formula: $\Phi = BA\cos\theta$, where B is the flux density (gauss per area unit), A is the surface area, and θ is the magnet's spatial configuration.[10] The flux density (B) is constant for the material of the magnet and therefore serves as the most practical measure of magnetic field strength. In contrast, A is the size of the magnet and θ is its spatial orientation. A large magnet generally creates stronger magnetic fields compared with a small magnet made of the same material.[11] Hence, the flux density of a 5 G to 10 G would have a weaker and weaker pull force as the size of the magnet decreases. In addition, the magnetic field strength decreases as an inverse square function of the distance from the source.[1] Accordingly, a distance of only a few millimeters away from the CIED could substantially reduce the electromagnetic interference.

In our study, all the magnetic field readings taken over the magnets were stronger than the recommended 5 G to 10 G threshold. However, the reading at the faceplate was substantially lower, and the readings for most dermatoscopes were safely below the 5-G threshold. For VEOS HD1 and HD2, a measure below 10 G is generally considered still safe by many investigators.[1,3,4,6] Thus, the small size of the magnets in the tested dermatoscopes and the few centimeters' recess between the magnet and the faceplate explain the measurement differences between readings at the faceplate and over the magnet. At a distance of a 0.5 cm, which is the approximate distance from the skin when noncontact dermoscopy mode is used, the magnetic field strength was categorically below the safety threshold for all devices tested. Consistently, we observed no disruptions or changes to ex vivo CIEDs from any of the tested dermatoscopes after prolonged exposures in the laboratory and even when exposed to old-generation CIEDs, which are generally more susceptible to electromagnetic interference.[1]

Integration of the 2 parts of our study suggests that relying solely on the gauss measure of the magnet in dermatoscopes may result in the overestimation of the risk they pose to patients with CIEDs. Furthermore, the 15 cm distance rule is evidently an excessive precaution and is an impractical distance for dermoscopy application. In real-life scenarios, dermatoscopes likely present no measurable adverse outcomes for patients with CIEDs.

Note that we did not test dermatoscopic attachments, such as cameras, cellular phones, or computer tablets. These devices likely contain larger and stronger magnets. We advise that they not be used within 15 cm of a CIED until they have been further tested. Moreover, other implanted devices (eg, cerebrospinal fluid shunts) may require similar precautions.[12]

Limitations

A limitation of this study is that it did not involve human participation. The entire study was conducted in a laboratory.

Conclusions

On the basis of our literature review and experiments, we posit the following 4 recommendations when examining skin lesions in the vicinity of CIEDs:

1. Use dermatoscopes that do not contain magnets, if available.
2. Use polarized noncontact dermoscopy mode, given that as little as a 0.5 cm distance substantially reduces magnetic field strength.
3. Do not remove the faceplate because it provides additional distance and potential shielding.
4. Avoid using dermatoscopic attachments (such as cameras, cellular phones, or computer tablets) near CIEDs because the magnets in these devices are generally stronger than those in dermatoscopes.

This study revealed that the magnets in the 3 tested dermatoscopes had a low magnetic field strength at the faceplate and showed no measurable effects on CIEDs.

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Author Contributions: Drs Rishpon and A. Marghoob had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Rishpon, Braun, Weinstock, Kulju, Grenga, A. Marghoob.
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Conflict of Interest Disclosures: Dr Steffel reported receiving consultant and/or speaker fees from Amgen, Astra-Zeneca, Atricure, Bayer, Biosense Webster, Biotronik, Boehringer-Ingelheim, Boston Scientific, Bristol-Myers Squibb, Daiichi Sankyo, Medtronic, Novartis, Pfizer, Sanofi-Aventis, Abbott, and Zoll; being the owner of CorXL; and receiving grant support through his institution from Bayer Healthcare, Biosense Webster, Biotronik, Boston Scientific, Daiichi Sankyo, Medtronic, and St. Jude Medical/Abbott. Dr A. Marghoob reported providing free advice to Heine, Canfield, and 3GEN regarding their products; receiving honorarium from 3GEN for speaking on dermoscopy; and providing free advice to Heine, Canfield, and 3GEN regarding their products and receiving honorarium from 3GEN for speaking on dermoscopy. No other disclosures were reported.

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